The Role of Large Woody Debris in the Structure and Function of Stream Ecosystems of the White Mountains

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Impacts of Land Use to New England Rivers

- Late 1800's to early 1900's timber harvest – Liquidation of large forest blocks across entire watersheds.
- River Drives
- Slash Fires in Large Clear-cuts
- Agriculture in River Valleys
- Flood Control - Dredging, Berms, Gabions
- Transportation System - Crossings

1911 Clearcut Pemigewasset Watershed

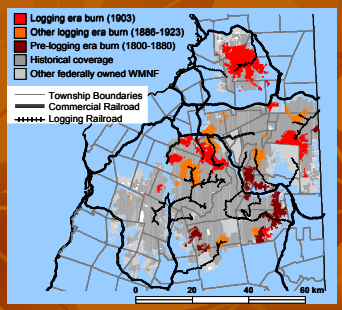
Road Terraces in the Wild River Watershed

River Drives

1903 Wild River Fire

Clearcut and Burned Land Rocky Branch of the Saco River

Historic Wildfires on The WNMF



Remnants of Riparian Old Growth W.B. of the Upper Ammonoosuc River

Agriculture in the Valley Bottoms

Protecting Infrastructure from the Big Floods

Effect of Land Use on Stream Condition

- Increased rate of run-off and sediment movement
- Over-widened streams- high stream width to stream depth ratio
- Reduced loadings of large woody debris
- Reduced pool occurrence
- Reduced forest canopy cover
- Loss of floodplain connectivity

Stream Habitat Inventories

- What are the baseline habitat conditions?
- What factors are limiting biological production of streams?
- What historic or current land use activities are influencing stream habitat conditions?
- What is the desired condition of riparian and stream ecosystems in the WMNF?

Maximum Water Temperatures

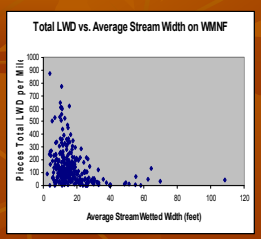
Stream Width Class (ft)	Average Max. Stream Temp. (F)	Low Temperature	High Temperature
0-15	66	47	76
16-30	65	49	75
>30	75	55	82

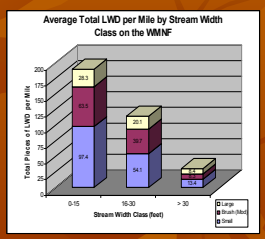
Water temperatures measured in mid-summer indicate that average maximum water temperatures in streams under 30' wide are well below 72 degrees F.

Results of Stream Habitat Inventories on the WMNF

Stream Width Class (ft)	# of Reaches	Pools (#/mi)	% Pools	% Riffle	Fish Cover
0-15	178	12.7	5.5	70.0	3.0
16-30	89	7.6	5.3	72.5	3.3
> 30	21	3.3	3.2	73.6	3.4

LWD Occurrence on the WMNF





Management Implications

Results of the WMNF stream habitat inventory effort and other Forest Service studies indicate the one variable that stands to affect stream ecosystems over time at a watershed scale is the regeneration, growth, and mortality of riparian forests.

Current and Future LWD Loadings

White Mountain NF in the 1990's

- Average of 20 pieces of wood >12" dbh per mile of stream.
- Median = 16 per mile.

Wood Recruitment Model – 200 years

(FS NERS-Nislow)

- Average of 66 pieces of wood >12" dbh per mile of stream.
- Median = 66 per mile.

LWD – Role #1

- Creates habitat diversity including high quality pools.
- How much is too much?

LWD – Role #2

- Stable wood stores sediment and organic matter.
- Stabilizes stream banks and scours pools.

LWD – Role #3

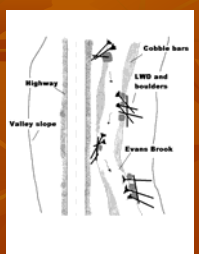
- Responsible for the dynamic nature of the White Mountain's aquatic ecosystems.

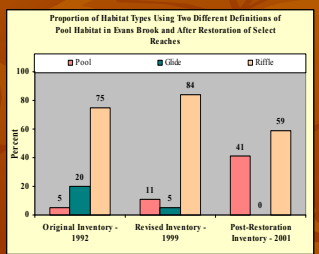
Stream Restoration: Demonstration Projects

Addressing Current Stream Conditions by restoring and enhancing stream habitat features appropriate with the river reach morphology.

1. Reducing width to depth ratios.
2. Storage of sediment and reclaiming floodplains.
3. Increasing LWD
4. Increasing Pool Frequency
5. Increasing storage of organics
6. Improving low flow fish habitat
7. Improving connectivity of habitats in watershed.
8. Increase invertebrate diversity and fish biomass.

Evans Brook Stream Restoration

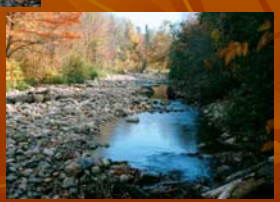




Evans Brook

Before Treatment:
Very poor low flow habitat resulting in poor fish movement ability.

After Treatment:
Reconstructing the low flow thalweg with pools and LWD.



Evans Brook

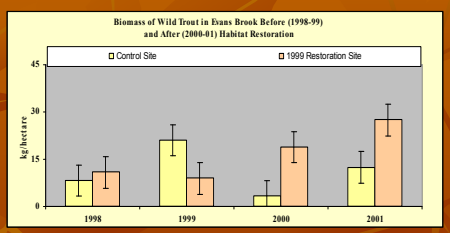
Before Treatment: excess cobble bed-load prevents maintenance of quality pool habitat.

After Treatment: Creation of cobble bars and using whole trees to maintain quality pool habitat.

Evans Brook

Pre-treatment **Post-treatment**

Monitoring the Fish

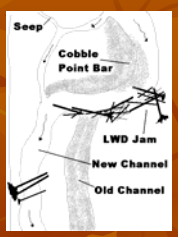


- Restoration site changed from low productivity (8 kg/hect) to medium productivity (>15 kg/hect).
- This site would now qualify for the wild trout program in NH.

Unexpected benefits of the Evans Brook Project

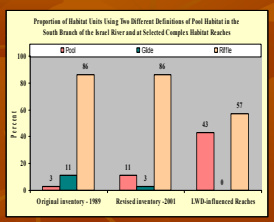
- Improved migration routes for fish during times of drought and heat.
- Increased open ice areas in winter.
- Continual demonstration value to share with other agencies, partners, and consultants.

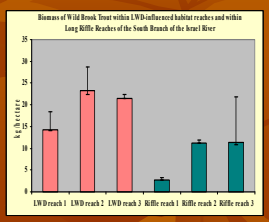
South Branch Israel River Habitat Inventory



- Understand how natural wood recruitment influences habitat in White Mountain streams.

Comparison of LWD-Influenced Stream Reaches and "Typical" Riffle Reaches South Branch of Israel River



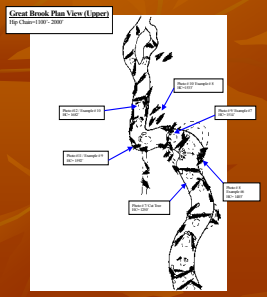


- Results very similar to Evans Brook Restoration Sites

Great Brook Watershed: Addressing the Questions

- Can addition of LWD, restoring of channel form, storage of sediment and organic material, and the increased frequency of quality pool habitat throughout the entire watershed improve stream productivity?
- Monitor changes in fish biomass, invertebrate densities, organic storage, sediment storage, pool quality.

Great Brook Stream and Watershed Restoration



- Prescribing the reach level treatments.
- Reading where the wood would wedge; sediment would be stored; and the pools would form.

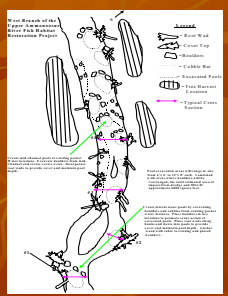
Great Brook Watershed and Habitat Restoration – 1st Phase of 5

- Before – poor refuge for aquatic life during drought periods.
- After – Improved holding water for fish and processing areas for invertebrates.

Great Brook Stream Restoration

Formation of debris jams from rain events during fall of 2003

West Branch of the Upper Ammonoosuc River



- Evidence of river drives and loss of large white pine forests.
- First large scale river project on WMNF in State of NH.
- Three year project improving a mile of river.
- Can we improve the quality of a wild brook trout fishery?

West Branch of the Upper Ammonoosuc River

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West Branch of the Upper Ammonoosuc River


Spring Flows and Ice Out

Conservation of the Native Eastern Brook Trout in the White Mountain National Forest

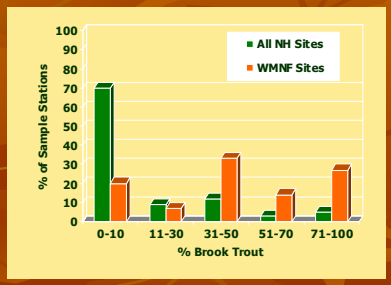
- How will pressures of economic growth, urban sprawl, and landscape fragmentation affect the U.S. range of the Eastern brook trout in the next 50 years?
- Trend of decline in ranges of species needing large blocks of unfragmented forests and river networks.
- Public lands are being viewed as critical component in long term conservation of these kinds of species.

Priorities for Conservation of Native Brook Trout at the Watershed Scale

- What size watershed is appropriate?
- How does conservation of wild trout fit with need for managing hatchery-based recreational fisheries?
- Are dams and impassable stream crossings barriers to conservation or opportunities for management?

White Mountain Streams Versus all New Hampshire Streams

- Brook trout absent or rare in 70% of NH sample sites.
- Brook trout are dominant fish species in 75% of WMNF sample sites.



Wild Trout Assessment

Forest Service using State of New Hampshire Wild Trout assessment protocol to evaluate priorities areas and to determine if management can improve wild trout productivity.

Mill Brook Watershed

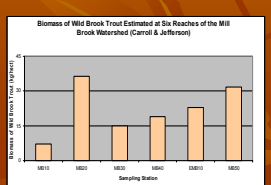
- Calcium-rich portion of the National Forest.
- Over 10 square miles of watershed on public land and over 5 miles of stream.
- Existing dam downstream of National Forest boundary.

NHF&G Wild Trout Productivity Classes

- Separated watershed into reaches for determining trout productivity.
- Fin-clipped all stocked trout.
- In 2003, six 100m stations were sampled using depletion electro-fishing techniques.
- Productivity Classes
  Low = < 15 kg/hect
  Medium = 15 to 35 kg/hect
  High = > 35 kg/hect

Wild Trout Productivity in Mill Brook

Low productivity = 1 station
Med. productivity = 4 stations
High productivity = 1 stations



Improving Fish Productivity of Mill Brook

Habitat Improvement Potential

- Increase LWD, pool frequency, storage of organics, invertebrate diversity, and fish productivity class.
- Work at Evans Brook improved reach from low productivity class (8 kg/hect) to medium class (20 kg/hect) in two years.
- Existing dam just downstream of public land boundary could be used to segregate stocked fish from wild fish.

Closing

- Large woody debris (LWD) appears to influence structure and function of White Mountain streams.
- Naturally unconfined rivers may develop more complex habitat features with the continual accumulation of LWD as second growth forests over-mature.
- Stream habitat restoration using LWD, applied in carefully selected watersheds, can demonstrate benefits of wood in streams.
- Opportunities to combine native brook trout conservation and stream habitat restoration in select watersheds.